



# **INTEGRATED SCIENCE**

## **ATAR course examination 2017**

### **Marking Key**

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

Section One: Multiple-choice

20% (20 Marks)

1				D
2			C	
3		B		
4		B		
5			C	
6				D
7	A			
8	A			
9		B		
10			C	
11				D
12			C	
13	A			
14			C	
15		B		
16			C	
17	A			
18		B		
19				D
20	A			
	5	5	6	4

Section Two: Short response

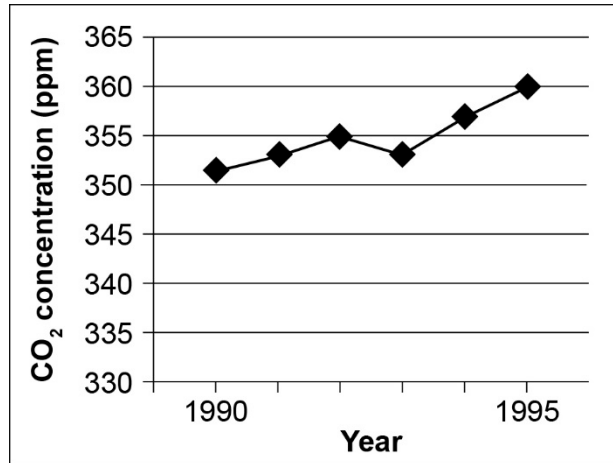
50% (95 Marks)

Question 21

(24 marks)

- (a) Using the grid below, construct an appropriate graph showing the concentrations of carbon dioxide from 1990 to 1995 using the data in the table on page 8. (5 marks)

**Atmospheric concentrations of carbon dioxide between 1990 and 1995 at Cape Grim**



Description	Marks
Line graph	1
Labels for the x and y axis	1
Units for the x and y axis	1
Appropriate scales for the x and y axis	1
Appropriate title for the graph	1
<b>Total</b>	<b>5</b>

- (b) Use the data in the table on page 8 or your graph to predict the carbon dioxide concentration in 1997. (1 mark)

Description	Marks
363 ppm (allow 361 ppm to 370 ppm)	1
<b>Total</b>	<b>1</b>

- (c) In 2016, the carbon dioxide concentration was 401.56 parts per million. Calculate the percentage increase between 1995 and 2016. Show **all** workings. (2 marks)

Description	Marks
Concentration increase: $401.56 - 360 = 41.56$ ppm	1
% increase = $\text{increase/original} \times 100 = 41.56 / 360 \times 100 = 11.54\%$ .	1
<b>Total</b>	<b>2</b>

Question 21 (continued)

- (d) Suggest **one** reason why atmospheric concentrations of carbon dioxide have increased significantly since the Cape Grim Baseline Air Pollution Station was established in 1976. (1 mark)

Description	Marks
Answers could include: <ul style="list-style-type: none"> <li>• more pollution</li> <li>• more greenhouse gases have been emitted</li> <li>• humans are consuming more fossil fuels.</li> </ul> Accept any suitable answer which describes the situation where more greenhouse gases have been released through human activities	1
<b>Total</b>	<b>1</b>

- (e) Draw a well-labelled diagram, illustrating how the release of additional greenhouse gases into the Earth's atmosphere is resulting in the enhanced greenhouse effect. (6 marks)

Description	Marks
Well-labelled diagram	1
One mark for each of the following correctly labelled items: <ul style="list-style-type: none"> <li>• Earth/ground</li> <li>• Atmosphere</li> <li>• Sun's rays (incident rays)</li> <li>• reradiated from ground</li> <li>• reradiated in all directions by greenhouse gases.</li> </ul>	1–5
<b>Total</b>	<b>6</b>

- (f) In the table below, identify and describe **three** ways (other than the carbon dioxide example provided) in which using coal-based electricity production can affect the environment. (9 marks)

Description	Marks
Three marks for each way. One mark for source, one mark for effect and one mark for how the environment is affected. Maximum nine marks.	
Answers could include: <ul style="list-style-type: none"> <li data-bbox="284 436 1273 504">• resource extraction disturbing natural ecosystems – land erosion - reduced land and muddy rivers etc</li> <li data-bbox="284 504 1273 571">• land clearing for resource extraction – loss of available land for plants and animal corridors</li> <li data-bbox="284 571 1273 638">• production of wastes, including nuclear and fly ash – contamination of lands and air - cancer, soil, water pollution</li> <li data-bbox="284 638 1273 705">• consumption and pollution of water – building dams, lowering water table – changes available water resources for ecosystems.</li> </ul> Accept other relevant answers	1–3 1–3 1–3 1–3
<b>Total</b>	<b>9</b>

Question 22

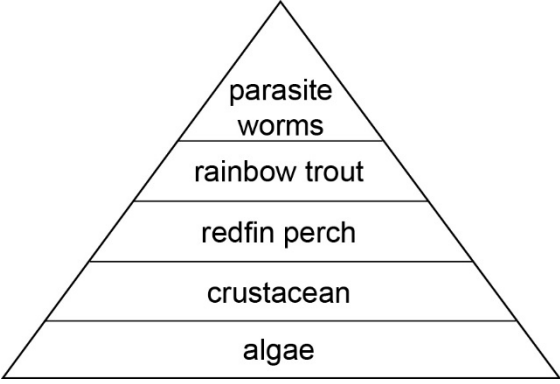
(14 marks)

- (a) Draw a food chain for the above organisms. (2 marks)

Algae → Crustacean → redfin perch → rainbow trout → parasitic worms

Description	Marks
Order of organisms correct	1
Direction of arrows correct	1
<b>Total</b>	<b>2</b>

- (b) Complete the energy pyramid below for this food chain. (2 marks)

Description	Marks
Two marks for correctly labelled level in food chain order from the food chain given from part (a). One mark if it has a minor error.	
Example: <div style="text-align: center;">  </div>	1–2
<b>Total</b>	<b>2</b>

- (c) If a rainbow trout eats 1 kg of redfin perch, it gains only about 60 g in mass. Outline **two** reasons why so little of the mass of the redfin perch is converted into the mass of the rainbow trout. From the(4 marks)

Description	Marks
Two marks for each reason outlined. One mark if reason is only listed. Maximum four marks.	
Answers could include:	
• respiration (of rainbow trout) – respiratory wastes produced	1–2
• digestion (of redfin perch – mass lost in non-digestible material and other excreted wastes	1–2
• movement (of rainbow trout) – energy used increases respiration rate, hence increases wastes produced.	1–2
<b>Total</b>	<b>4</b>

- (d) In a rainbow trout farm, one of the most common causes of disease and death is poor water quality. Complete the table below, listing **three** key factors that affect water quality and name the test that can be used to measure each factor. (6 marks)

Description	Marks
Two marks for each key factor. One mark for factor, one mark for test. Maximum six marks.	
Answers could include: <ul style="list-style-type: none"> <li>• Temperature – thermometer</li> <li>• dissolved oxygen – dissolved oxygen sensor</li> <li>• pH – pH meter</li> <li>• salinity – total dissolved solids (TDS) or electrical conductivity</li> <li>• suspended solids – total suspended solids (TSS) or Turbidimeter</li> <li>• phosphate <b>or</b> nitrate levels with appropriate test</li> <li>• toxic waste levels such as ammonia and flow rates with appropriate test.</li> </ul>	1–2 1–2 1–2 1–2 1–2 1–2 1–2
<b>Total</b>	<b>6</b>

Question 23

(17 marks)

- (a) What is the original source of groundwater? (1 mark)

Description	Marks
Ground water originally sourced from rain.	1
<b>Total</b>	<b>1</b>

- (b) List **four** negative consequences if the consumption of groundwater resources continues to increase. (4 marks)

Description	Marks
One mark for each consequence	
Answers could include: <ul style="list-style-type: none"> <li>• the level of the water table will fall</li> <li>• the ground water will become saline</li> <li>• surface lakes will dry out and the dependent ecosystems will fail</li> <li>• the salinity of the groundwater will cause trees to die.</li> </ul>	1–4
Accept other relevant answers	
<b>Total</b>	<b>4</b>

- (c) List **two** strategies that could be used to ensure that the quantity of water resources in Western Australia is maintained. (2 marks)

Description	Marks
One mark for each strategy	
Answers could include: <ul style="list-style-type: none"> <li>• decreased consumption (accept increasing water efficiency)</li> <li>• aquifer recharge.</li> </ul>	1–2
Accept other relevant answers	
<b>Total</b>	<b>2</b>

- (d) After water is used in the home, it is usually pumped to wastewater treatment plants. Explain **why** domestic wastewater requires treatment before it can be returned to the environment. (2 marks)

Description	Marks
Answers could include: <ul style="list-style-type: none"> <li>• it contains pathogens that can cause disease</li> <li>• to remove solids – as solid material decays, it uses up oxygen, which is needed by the plants and animals living in the water.</li> </ul>	1–2
Accept other relevant answers	
<b>Total</b>	<b>2</b>



- (e) Explain **how** domestic wastewater can be treated to allow the water content to be returned to the environment. Include a flow diagram in your response. (5 marks)

Description	Marks
Appropriate flow diagram showing: Domestic wastewater → Treatment → Wastewater treated This can be septic tank <b>or</b> 1°, 2°, 3° processing	1–2
Explanation to include: Screening, sedimentation, bio-digestion, chlorination <b>or</b> two compartment tank, sedimentation, bacterial activity, gravel soak pit	1–3
<b>Total</b>	<b>5</b>
Accept other relevant answers	

- (f) Given that rainfall fell by 15%, explain how the stream flow could decrease by 75%. (3 marks)

Description	Marks
Recognition that:	
• runoff occurs when soil is saturated	1
• less rain means it is saturated less often	1
• frequent small rain events means less runoff.	1
<b>Total</b>	<b>3</b>
Accept other relevant answers	

Question 24

(16 marks)

- (a) Explain how diffusion occurs. (2 marks)

Description	Marks
Diffusion is the random movement of particles	1
from an area of high concentration (or pressure) to an area of low concentration (or pressure)	1
<b>Total</b>	<b>2</b>

- (b) What is meant by the term 'concentration gradient' and how does it affect the rate of diffusion? (2 marks)

Description	Marks
The difference in concentration between two different areas	1
The higher the gradient the greater the rate of diffusion. (This difference (or gradient) influences the rate of diffusion)	1
<b>Total</b>	<b>2</b>

- (c) In the table below, identify **three** important physical features of fish gills that enable their gas exchange surface to be efficient and outline how each feature helps the gas exchange process to occur. (6 marks)

Description	Marks
Two marks for each feature. One mark for stating feature, one mark for outline. Maximum six marks.	
Answers could include:	
• moist – to allow gases to be in solution for diffusion to occur	1–2
• very thin – to enable gases to diffuse quickly	1–2
• large surface area – to allow efficient exchange of gases	1–2
• large number of gills – to increase surface area.	1–2
<b>Total</b>	<b>6</b>

- (d) Complete the table by calculating the average breathing rate for the fish in water at 5 °C. (1 mark)

Description	Marks
9.8 mL of water per minute (accept 10)	1
<b>Total</b>	<b>1</b>

- (e) Refer to the data from the table to explain how temperature affects the breathing rate of fish. (3 marks)

Description	Marks
Refers to the data to show relationship: e.g. At 25 °C the breathing rate is 42 and at 10 °C the breathing rate average is 20	1
States relationship: As temperature increases the breathing rate increase <b>or</b> As temperature decrease the breathing rate decreases	1–2
<b>Total</b>	<b>3</b>

- (f) Explain why the researcher was required to remove the fish. (2 marks)

Description	Marks
The investigation had gained animal ethics approval – hence in performing the scientific procedure the researcher had to consider the welfare of the fish in conducting the investigation  Accept other relevant answers where animal ethics are considered	1–2
<b>Total</b>	<b>2</b>

Question 25

(24 marks)

- (a) Identify **one** fuel that is used in a conventional power station in Australia. (1 mark)

Description	Marks
Coal <b>or</b> Natural gas	1
<b>Total</b>	<b>1</b>

- (b) Draw a flow chart showing how large-scale electricity generation occurs in a power station using the fuel identified in part (a). For each part of your flow chart describe the process taking place. (8 marks)

Description	Marks
Four marks for flow chart. One mark for each part to a maximum of four marks.	
Answers could include: Flow chart to show four components Fuel → combustion → heat → turbine → electricity	1–4
Four marks for description One mark for each process outlined	
Answers could include: <ul style="list-style-type: none"> <li>• fuel is burnt</li> <li>• combustion produces heat</li> <li>• heat is used to move turbine</li> <li>• moving turbine produces electricity.</li> </ul>	1–4
<b>Total</b>	<b>8</b>

- (c) For the fuel you selected in part (a), in each of the following question parts, select a response by drawing a circle around the correct answer and then provide **one** reason to justify your response.

- (i) The efficiency of the process by which the input fuel is converted into electricity is (2 marks)

High 50% or more
---------------------

Low Below 40%
------------------

Description	Marks
One mark for correct efficiency and one mark for reason	
Gas – high efficiency – high methane content <b>or</b> Coal – low efficiency – coal is wet and much energy is lost in drying it as it burns	1–2
<b>Total</b>	<b>2</b>

- (ii) The relative amount of greenhouse gas emitted using this fuel is (2 marks)

High

Low

Description	Marks
One mark for amount and one mark for reason	
Gas – low – produces two water molecules for every carbon dioxide molecule <b>or</b> Coal – high – pure carbon produces CO <sub>2</sub>	1–2
<b>Total</b>	<b>2</b>

- (iii) The suitability of this fuel for the provision of base load electricity supply is (2 marks)

High

Low

Description	Marks
One mark for suitability and one mark for reason	
Gas – Low – expensive <b>or</b> Coal – High – cheap	1–2
<b>Total</b>	<b>2</b>

Question 25 (continued)

- (d) For the fuel identified in part (a), state **one** advantage and **one** disadvantage of using this fuel for base load electricity supply in terms of economic and social impact. (4 marks)

Description	Marks
Economic impact – advantage and disadvantage – two marks	
Answer could include:	
Advantage: <ul style="list-style-type: none"> <li>• Gas – burns cleanly – little cost in pollution clean up</li> <li>• Coal – plentiful supply low cost in recovery of resource</li> </ul>	1
Disadvantage: <ul style="list-style-type: none"> <li>• Gas – does produce carbon dioxide – long-term pollution may be costly</li> <li>• Coal – does not burn cleanly – large cost in pollution clean up</li> </ul>	1
Social impact – advantage and disadvantage – two marks	
Answer could include:	
Advantage: <ul style="list-style-type: none"> <li>• Gas – burns cleanly and does not leave unsightly ash, soot and bad odours behind that could affect the well-being of individuals and families.</li> <li>• Coal: – is in plentiful supply and therefore its use can create jobs for individuals and families in the long term</li> </ul>	1
Disadvantage: <ul style="list-style-type: none"> <li>• Gas – extracted from environmentally sensitive areas and therefore can have an effect of the activities of a community</li> <li>• Coal – does not burn cleanly and leaves unsightly ash, soot and bad odours behind that could affect the well-being of individuals and families</li> </ul>	1
<b>Total</b>	<b>4</b>
Accept other relevant answers	

- (e) Calculate the energy saved each day by changing **all** the lights to LED globes. Show **all** workings. (5 marks)

Description	Marks
Calculates the number of seconds in a day $t = 24 \times 60 \times 60 = 86400 \text{ s}$	1
Option 1	
Energy used by 100 W globe $E = 100 \times 86400 = 8640000 \text{ J}$ Energy used by 20 W globe $E = 20 \times 86400 = 1728000 \text{ J}$	1
Difference between the two globes $8640000 \text{ J} - 1728000 \text{ J} = 6912000 \text{ J}$	1
Energy saved for 200 lights $6912000 \text{ J} \times 200 =$	1
$1382400000 \text{ J} (1382.4 \times 10^6 \text{ J})$	1
Option 2	
Power difference between the two light globes $P = 100 - 20 = 80 \text{ W}$	1
Energy saved by 80 W $E = 80 \times 86400 = 6912000 \text{ J}$	1
Energy saved for 200 lights $6912000 \text{ J} \times 200 =$	1
$1382400000 \text{ J} (1382.4 \times 10^6 \text{ J})$	1
<b>Total</b>	<b>5</b>

Section Three: Extended response

30% (56 Marks)

Question 26

(27 marks)

- (a) (i) Is Wetland A or Wetland B **more** likely to be polluted? Circle your answer. (1 mark)

Description	Marks
Wetland B is circled	1
<b>Total</b>	<b>1</b>

- (ii) Use the information from Table 1 and Table 2 to outline **two** reasons to support your answer. (4 marks)

Description	Marks
Two marks for each reason.	
Answers could include: <ul style="list-style-type: none"> <li>• B has more round worms / flat worms as round worms / flatworms are tolerate to an increase in pollution</li> <li>• B has no mayflies / caddis fly larva or few shrimp as no mayflies / caddis fly larva or few shrimp are not tolerate to an increase in pollution.</li> </ul>	1–2
Accept other relevant answers	
<b>Total</b>	<b>4</b>

- (b) Identify how the values of dissolved oxygen and suspended solids change downstream at 2 km and downstream at 6 km. For each change you have identified, give a reason why it occurred. (8 marks)

Description	Marks
At 2 km suspended solids: suspended solids increase	1
Reason: as a result of sewage overflow	1
At 2 km dissolved oxygen: oxygen content lowers	1
Reason: due to increase number of bacteria consuming the oxygen	1
At 6 km suspended solids: suspended solids decrease	1
Reason: The suspended solids become diluted or are consumed downstream	1
At 6 km dissolved oxygen: oxygen levels increase	1
Reason: as bacteria count drops	1
<b>Total</b>	<b>8</b>

- (c) Write an hypothesis for this investigation. (2 marks)

Description	Marks
Statement that gives relationship between independent and dependent variable	2
Statement that links independent and dependent variable without indicating the direction of the relationship between the variables	1
<b>Total</b>	<b>2</b>
Example of a two mark answer: Salt water concentrations over 20 g/L negatively affects growth of pigface.	



- (d) Complete the table below to show the weekly growth rates of the pigface plants used in the investigation. (4 marks)

Description	Marks
Plant 1: 5, 4, 5, 4	1
Plant 2: 3, 3, 2, 1	1
Plant 3: 3, 2, 1, 0	1
Plant 4: 2, 1, 1, 0	1
<b>Total</b>	<b>4</b>

- (e) Explain why Cooper used the difference in the length of the plants rather than their final length when analysing the effect of salt concentration on them. (2 marks)

Description	Marks
He wanted to see how the growth was affected by the different salt concentrations. The initial lengths of the pigface were not the same, so measuring the final length only would not show growth rates.	1–2
<b>Total</b>	<b>2</b>

- (f) Identify **four** design faults (errors in method) in Cooper's investigation. (4 marks)

Description	Marks
One mark for each fault	
Answers could include: <ul style="list-style-type: none"> <li>• plants type not appropriate</li> <li>• only one trial per category</li> <li>• plants not identical</li> <li>• soil not identical</li> <li>• length measured to nearest centimetre</li> <li>• water not measured.</li> </ul> Accept other relevant answers	1–4
<b>Total</b>	<b>4</b>

- (g) Can a valid conclusion be drawn from this experiment? Circle your answer and provide a reason for your answer. (2 marks)

Description	Marks
No	1
The experiment is not valid due to many design faults	1
<b>Total</b>	<b>2</b>

Question 27

(29 marks)

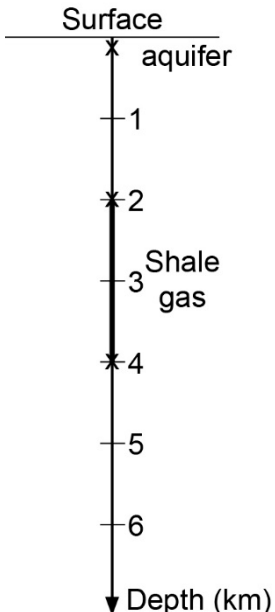
- (a) Describe the potential effect of fracking on the usable quantity of natural gas resources in Western Australia. (5 marks)

Description	Marks
Extends lifetime as more natural gas is made available	1
Quantifies increase ( ie 1220 TCF v 150 TCF – accept Gm <sup>3</sup> equivalent)	1
States that rate is based on current demand	1–2
	1
<b>Total</b>	<b>5</b>

- (b) Identify **one** social, **one** environmental and **one** economic reason why shale gas resources might not be developed in Western Australia. (3 marks)

Description	Marks
Valid social reason; answers could include: <ul style="list-style-type: none"> <li>• community don't want it / protest against it</li> <li>• impacts to Aboriginal Heritage</li> <li>• many governments have 'fracking' moratoriums.</li> </ul>	1
Valid environmental reason; answers could include: <ul style="list-style-type: none"> <li>• climate change</li> <li>• emits greenhouse gases</li> <li>• clearing of vegetation for exploration and/or production wells</li> <li>• may cause habitat fragmentation due to the need to construct access roads to wells etc.</li> </ul>	1
Valid economic reason; answers could include: <ul style="list-style-type: none"> <li>• costs more to produce than the current natural gas price</li> <li>• setup costs make it uneconomical</li> <li>• exploration costs make it uneconomical</li> <li>• resources in the Canning Basin are far away from existing infrastructure (this isn't the case for the Dandaragan Trough)</li> <li>• the NW Shelf (offshore resources) are more than enough to meet current demand.</li> </ul>	1
<b>Total</b>	<b>3</b>
Accept other relevant answers	

- (c) Complete the simple depth profile for the aquifers and shale gas by marking the depth at which each would be located. Use this to discuss the potential impact of the extraction of shale gas on the quality of water in the aquifers. (5 marks)

Description	Marks
	<p>Profile: One mark for correct depth of aquifer One mark for correct depth of shale gas</p> <p style="text-align: center;">1-2</p>
Impact on the quality of water:	
Likely to be none	1
the shale and fracking activities are separated by several km	1
Unless there is a failure of the pipe which goes through the aquifer	1
<b>Total</b>	<b>5</b>

- (d) Explain what is meant by the term 'biofuel' and give **one** example. (3 marks)

Description	Marks
Explanation includes:	
Liquid fuel	1
which is derived from biomass (accept plant and/or animal matter)	1
Example could include:	
<ul style="list-style-type: none"> <li>• biodiesel</li> <li>• ethanol</li> <li>• canola /vegetable or similar food based oil (can be used, although not ideal).</li> </ul>	1
Do not accept solid fuels as these are not 'biofuels' but are biomass resources	
<b>Total</b>	<b>3</b>

Question 27 (continued)

- (e) State why biofuels are considered a renewable source of energy. (1 mark)

Description	Marks
Answers could include: <ul style="list-style-type: none"> <li>they grow again or be replaced</li> <li>are not permanently used up</li> <li>they do not run out</li> <li>can be derived from waste products (used fish and chip oil).</li> </ul> Accept other relevant answers	1
<b>Total</b>	<b>1</b>

- (f) Name the original source of energy that is stored as chemical energy in biomass. (1 mark)

Description	Marks
Sun	1
<b>Total</b>	<b>1</b>

- (g) Given that the specific heat capacity of water is 4.186 joule/gram/degree Celsius, calculate the heat energy, in joules, taken in by the water after burning 0.75 g of the biofuel. Show **all** workings. (3 marks)

Description	Marks
Temperature change = $37.2 - 20.5 = 16.7$	1
$50 \text{ g} \times 16.7 \times 4.186 =$	1
3495 J	1
<b>Total</b>	<b>3</b>

- (h) The chemical data sheet for the biofuel stated that it should release 21 670 J of heat per gram when burned. Calculate the temperature change of the water after burning 0.75 g of biofuel. Assume that the apparatus is 100% efficient. Show **all** workings. (3 marks)

Description	Marks
Identify $Q = 21\ 670 \times 0.75 = 16252.5 \text{ J}$	1
$\Delta T = 16252.5 / 50 \times 4.186 =$	1
77.7	1
<b>Total</b>	<b>3</b>

- (i) Calculate the energy output where the biofuel energy input (energy consumed) is 21 670 J and the process is 28% efficient. Show **all** workings. (3 marks)

Description	Marks
Rearranges : $\text{Output} = \text{efficiency} \times \text{input}$	1
$\text{Output} = 0.28 \times 21\ 670 =$	1
6067.6 J	1
<b>Total</b>	<b>3</b>

(j) List **two** reasons why part (i) is not 100% efficient.

(2 marks)

Description	Marks
One mark for each reason	
Answers could include: <ul style="list-style-type: none"><li>• heat passed over the flask and was not constrained to be directly funnelled into it</li><li>• the flame did not burn the biofuel completely.</li></ul> Accept other relevant answers	1–2
<b>Total</b>	<b>2</b>

This document – apart from any third party copyright material contained in it – may be freely copied, or communicated on an intranet, for non-commercial purposes in educational institutions, provided that it is not changed and that the School Curriculum and Standards Authority is acknowledged as the copyright owner, and that the Authority’s moral rights are not infringed.

Copying or communication for any other purpose can be done only within the terms of the *Copyright Act 1968* or with prior written permission of the School Curriculum and Standards Authority. Copying or communication of any third party copyright material can be done only within the terms of the *Copyright Act 1968* or with permission of the copyright owners.

Any content in this document that has been derived from the Australian Curriculum may be used under the terms of the Creative Commons [Attribution 4.0 International \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) licence.

*Published by the School Curriculum and Standards Authority of Western Australia  
303 Sevenoaks Street  
CANNINGTON WA 6107*